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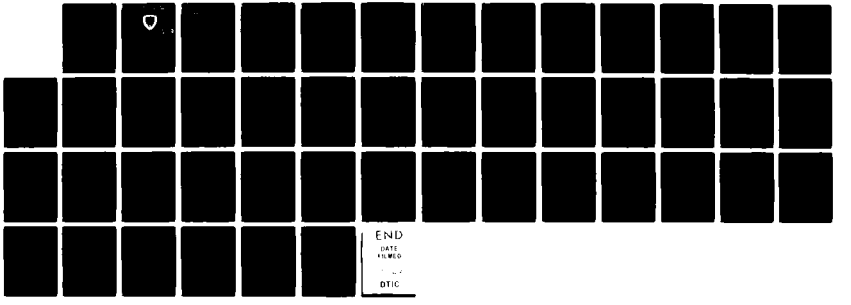

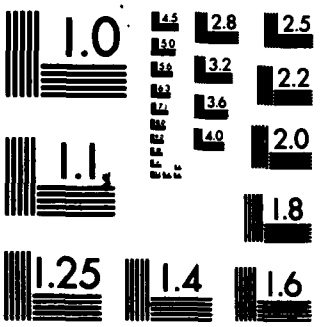

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U. S. ARMY COMMUNICATIONS RESEARCH AND DEVELOPMENT COMMAND

Fort Monmouth, New Jersey

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Final Report

MARKET STUDY Of MILITARY/GOVERNMENT DISPLAY REQUIREMENTS For

Center for Tactical Computer Systems (CENTACS)

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Prepared by

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Final Report

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For

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(CENTACS)

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Prepared by
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PREFACE

This report was prepared by Interstate Electronics Corporation (IEC), Anaheim, California, a subsidiary of A-T-O Inc., under Department of the Army Contract DAAB07-78-C-2032 for the Center for Tactical Computer Systems (CENTACS), Communications Research and Development Command (CORADCOM), Fort Monmouth, New Jersey. CENTACS is one of three research and development centers in CORADCOM, and specifically, CENTACS is the focal point within the Department of the Army Materiel Development and Readiness (DARCOM) for overall engineering support of tactical command systems based on computers. This report covers work performed between August 1978 and August 1979.

Principal contributors to this study are Mr. Sid Wing, Director of Marketing, and Mr. Carl Boland, Advanced Systems Manager, both of Computer Product Operations, Interstate Electronics Corporation.

The authors wish to acknowledge the contributions of Mr. Sil Pelosi, Deputy Director (CENTACS), and Mr. Joe Pucilowski, COR (CENTACS). Appreciation is also extended to all survey participants for their cooperation and assistance in this study.

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Section 1
INTRODUCTION

1.1 SPECIFIC OBJECTIVES

Interstate Electronics Corporation (IEC) undertook this study to:

- Collect and document pertinent requirements of numerous military/ government display needs within the defined scope
- Identify areas of substantial commonality or dispersion between requirements
- Classify and segment requirements as dictated by survey findings. Candidate areas for segmentation include the following:
  - Operational performance requirements
  - Performance characteristics
  - Environmental requirements
  - Application
  - Cost objectives
- Establish a profile of program-related priorities pertaining to display equipment

- Determine market size as represented by those requirements surveyed

- Identify areas of product capability or technology advances that will be most responsive to multiple program needs

1.2 STUDY PURPOSE

The study was a thorough investigation of military/government information display needs. The purpose was to identify, describe, classify, and organize a representative sampling of display requirements. Both current and prospective needs were addressed. As expected, the investigation determined the degrees of commonality that exist over a wide range of government display applications. Findings will expose candidate areas for responsive product or technology development. The study should complement efforts by industry and government in effective resource allocation and product planning.

1.3 SCOPE

The study was directed at computer-driven display needs that require performance, reliability, or environmental capabilities that exceed commercial standards. Military programs, being most representative of such added capabilities, received primary attention. Commercial standards are those generally associated with computer laboratory environments. Included were displays of sufficient image capacity to be considered page-oriented devices. Excluded were low-capacity displays (i.e., numerical readouts, cockpit displays, control indicators, and so forth).

Except where display facilities need be implemented within the terminal, the study excluded all terminal-oriented software programming.

The requirements as surveyed are a representative sampling of the overall military/government display market. However, the study should not be considered an attempt to survey or analyze the overall market.

Section 2
STUDY METHOD

The general approach of the study was to identify and analyze display requirements, not to focus on specific hardware or on technologies that will satisfy these needs.

The study consisted of three phases: (1) survey, (2) analysis, and (3) preparation of the report. The survey and analysis phases were closely coordinated with the Center for Tactical Computer Systems (CENTACS), Fort Monmouth, New Jersey.

2.1 SURVEY

The survey phase consisted of primary research of designated military/government activities by person-to-person interviews. A minimum of 20 separate military/government activities were to be surveyed consisting of 30 to 50 program elements with display content. Interviews were of a 1- to 2-hour duration, depending on the number of program elements covered. Interviews were unstructured, without questionnaires or formatted discussion. Discussions were topical and covered the subjects outlined under Survey Information. The results of all interviews were documented, and copies will be provided to CENTACS.

A list of respondent activities prepared by CENTACS included military program elements with information display content. CENTACS provided for the introduction of the interviewer to the early prospective respondents. Interstate Electronics also contributed to the list of prospective respondents and

suggested that CORADCOM participate as the first respondent to verify interview content. Because of the numerous program activities at CORADCOM, these initial interviews consumed some 4 to 6 hours.

The survey phase, as planned, was expected to be conducted over a 45- to 60-day period. This phase, however, was lengthened considerably because of the total number of respondents and their availability. The most time-consuming part of the survey phase was determining when both the interviewer and the respondent could be available.

2.2 ANALYSIS

The analysis phase was initiated by a presentation of survey data to CENTACS immediately following the survey phase. A consultation with CENTACS verified survey content and confirmed that the analysis approach was consistent with the information needs of the sponsor.

Survey data was first examined by individual requirements variables, and these characteristics were tabulated by quantitative measure or type to discern groupings or dispersions of capabilities. Specific requirement categories were selected by significance and their relative impact on other variables. Requirements were classified by category to facilitate description and analysis. Frequency distribution of classifications was determined by simple tabulation or cross-tabulation of categories. Specific needs were weighted by their occurrence and the quality of displays required over projected periods.

A particular goal of the analysis phase was to identify discrete levels of display capabilities that have common occurrence across diverse applications. Since average capabilities are of little use, the analysis attempts to discern capabilities responsible to the requirements spectrum. Where practical, statistical methods were employed to identify and measure commonality and dispersions between display requirements.

Trends were identified, where discernible, across historical, current, and projected requirements. For example, technological advances improving display utility present several areas for consideration, including display, capacity, interaction, and local processing power.

Inconsistencies in the findings are presented, as well as coherence, in the interest of validity. Explanations, opinions, or rationales offered by the authors are so indicated.

The analysis phase took 2 to 3 months (much longer than originally planned) allowing time for additional contact of some respondents for confirmation of earlier findings and for additional information.

Section 3
STUDY SURVEY AND FINDINGS

3.1 STUDY SURVEY

The survey phase of the study resulted in the survey of 38 programs, each with militarized display content consistent with the scope of the study. An objective of the study was to secure interviews with individual program officials with pertinent knowledge of program display requirements. Most of these respondents were able to provide information relating to application, performance factors, and program scheduling and quantities. Interviews often consisted of several respondents, each covering specific areas of program requirements.

All interviews were informal, with the interviewer querying respondents over a variety of display- and program-related topics. Interview content included the following areas:

- Description of program element
- Display application
- System considerations
  - Processor identification
  - Electrical and communications interface
  - Distribution network

- Operator consideration
  - Human factors
  - Operator interaction
- Information to be displayed
- Display capacity and screen size
- Installation factors
  - Size and weight
  - Mounting
  - Power operation
- Reliability
- Maintainability
- Operating/service life
- Image factors
  - Brightness
  - Contrast ratio
  - Ambient light conditions

- Display features
  - Scrolling
  - Editing
  - Data differentiation
  - Writing/update speeds
- Environmental considerations
  - Platform
  - Operating and nonoperating physical environmental requirements
  - EMI/Tempest/Nuclear
- Program factors
  - Schedule
  - Quantity requirements
  - Cost objectives
- Priority of needed improvements

The survey covered programs in various stages of maturity ranging from conceptual phase through full production. Although the purpose of the study was to provide information necessary to define product configurations and/or display technologies responsive to future military needs, programs in development or production phases were surveyed because they are representative of future

military display needs. Such mature programs were usually subject to capability updating as more responsive display devices become available through government and industry development.

Mature programs also provided the most detailed performance capabilities since these items were specified contract requirements. These respondents tended to restate display requirements of their contract or to model their requirements after available industry products. Although the survey was directed at establishing individual program needs, irrespective of specified or available display configurations, the mature programs may not reflect the actual display priorities of the programs.

Conversely, programs surveyed that were in the formulative or definition phase received responses that emphasized program display priorities with few detailed requirements. Such areas as electrical interface, operator interaction, power, and installation requirements were considered to be overall system considerations and the domain of the yet-to-be-selected development contractor.

Respondents were conservative in stating their individual display requirements. Program constraints of cost and schedule appeared to overshadow parenthetically stated areas of needed improvements that would contribute to operational effectiveness. The subject of needed display improvements is discussed in a later section.

Individual preferences for specific display technologies such as cathode-ray tube (CRT) or flat-panel display media were virtually nonexistent. Only in applications where performance requirements clearly eliminated a candidate technology was any reference made to suggested display types.

Display configuration profiles were established in each program consisting of type of information to be displayed, screen capacity or size, and environmental capability. Program-related factors of schedule and quantities were also readily defined.

Particular difficulty was experienced in attempting to establish display cost objectives in individual programs. The following factors apparently contributed to incomplete findings on this subject:

- Respondents appeared reticent to state budget figures that would inhibit a lower available price.
- Respondent simply did not know.
- Display content cost was hidden in the system cost.
- There was confusion over cost to the prime contractor or cost to the government
- Stated cost objectives were commonly unrelated to specific purchase quantities.

Considerable information was collected over the 38 surveyed programs. Respondents were particularlay receptive to the methodology of the interviews. Interviews were topical in nature where the respondent was first briefed on the purpose and objectives of the study. Several respondents were relieved to find they had no questionnaires to complete. The informal nature of the interview, with the interviewer taking notes during the discussion, is recommended for subsequent surveys that the sponsor may conduct. A further recommendation is made in the interest of more complete survey data. Program officials who are contacted pursuant to securing appropriate program respondents should be mailed a list of the topics to be discussed so that the eventual respondent is prepared. Verbal notification of the subjects to be surveyed often failed to reach the respondent.

3.2 SURVEY FINDINGS

In order that the survey phase would not be influenced by preconceived classifications of individual program display requirements, the analysis phase was deferred until survey completion. The analysis phase was initiated by an assessment of documented individual program interviews. Collected data was

first examined in each of the 15 information topics over all programs. The findings of each information topic were then tabulated for visibility of the spectrum of requirements. With spectrum visibility, each data topic was then categorized into one of three classifications:

- Apparent evidence of commonality of requirements
- Sufficient dispersion to preclude areas of commonality
- Insufficient data

This initial analysis yielded certain areas of commonality in the following topics:

- Information to be displayed
- Display capacity and screen size
- Environmental and packaging considerations
- Operating power requirements
- Maintainability
- Reliability
- Service life
- Human factors
- Image factors

Areas displaying significant dispersion of requirements included the following:

- Operator interaction
- Electrical and communications interface
- Physical and mounting requirements

Areas that presented insufficient data to determine evidence of commonality or dispersion were the following:

- Display data manipulation features (scrolling, editing, data differentiation, writing speeds)

- Cost objectives
- Needed improvements

While certain requirements areas over the spectrum of programs demonstrated commonality merits, there were few areas that possessed single common requirements. Such areas, however, did demonstrate discrete groupings of requirements that suggest multiple display configurations could effectively cover the application spectrum. Areas demonstrating significant dispersion and those of insufficient data could potentially be organized with more in-depth study; however, such analysis should be the objective of a further detailed study and outside the scope of this study.

Section 4
ANALYSIS

This section presents an analysis of each investigated area over all programs.

4.1 DISPLAYED INFORMATION

The spectrum of information presentations to be displayed over all programs included several types of information.

- Alphanumerics (A/N)
- Military symbology
- Vector graphics
- Incremental graphics
- Map overlay presentations
- Multicolor presentations
- Dynamic pictorial presentations (video)
- Plan position indicator (P.P.I.)

Combinations of the preceding display presentations occurred in five groupings:

- Alphanumerics only
- Alphanumerics, military symbology, and graphics
- Alphanumerics, military symbology, graphics, and map overlay
- Alphanumerics, graphics video, and P.P.I.
- Alphanumerics, graphics, and multicolor

The preceding presentation combinations occurred in the following program frequency and quantity requirements. Two of the 38 programs surveyed accounted for 14,000 of the 25,249 total display units. To present a broader display profile, the study findings in this section are shown both with (table 1) and without (table 2) the 14,000 units. The two programs, which dominate the quantity usage of the military display needs, cause a major shift in the data.

TABLE 1. TYPES OF DISPLAYED INFORMATION FOR ALL PROGRAMS SURVEYED

Category	Type	No. of Programs	Program Content (%)	Quantity Of Units	Quantity Content (%)
1	Alphanumerics only	15	40	16,286	65
2	Alphanumerics, military symbology, and graphics	11	29	1,627	6
3	Alphanumerics, military symbology, and overlay	5	13	1,840	7
4	Alphanumerics, graphics, video, P.P.I.	3	8	2,350	9
5	Alphanumerics, graphics, multicolor	4	11	3,146	12

TABLE 2. TYPES OF DISPLAYED INFORMATION WITHOUT SST AND MRTT

Category	Type	No. of Programs	Program Content (%)	Quantity Of Units	Quantity Content (%)
1	Alphanumerics only	13	36	2,286	21
2	Alphanumerics, military Symbology and graphics	11	31	1,627	14
3	Alphanumerics, military symbology, and overlay	5	14	1,840	16
4	Alphanumerics, graphics, video, P.P.I.	3	8	2,350	21
5	Alphanumerics, graphics, multicolor	4	11	3,146	27

Approximately 70 percent of the programs surveyed require display presentations in either category 1 or 2. Categories 3, 4, and 5 could be considered specialty display applications or an insufficient market sampling for conclusive data. Category 3, Alphanumerics-Military Symbology-Graphics-Map Overlay, was represented by only five programs (13 percent) and included those programs that specified map overlay as a firm requirement.

As shown in table 2, if the two programs, Single Subscriber Terminal (SST) and Modular Record Traffic Terminal (MRTT), with the attendant 14,000-unit requirement are deleted, 30 percent of the total displays required overlay, and another 20 to 30 percent of the programs would use the map overlay capability if it were available at a low and competitive cost. The map overlay feature was not specified by some of the programs because such a capability was not offered. This suggests that many other programs requiring the graphics capability would be definite candidates for the map overlay feature, particularly those programs requiring both alphanumerics and graphics.

Display information presentations of categories 1, 2, and 3 were prevalent in ground operational environments, namely Army and USMC, while the more exotic presentations of categories 4 and 5 were primarily requirements of Navy and Air Force programs. The Navy and Air Force program sampling was limited, however, and clearly less than representative.

4.2 DISPLAY CAPACITY/SCREEN SIZE

Survey findings on display capacity and screen size again offered a variety of capacity/screen size configurations:

- 50 characters by 25 lines
- 33 characters by 16 lines
- 72 characters by 24 lines
- 80 characters by 24 lines
- 12-inch diagonal screen
- 640 by 480 pixels
- 16-inch diameter
- 19-inch diameter

- 12-inch by 12-inch rectangular
- 16-inch by 16-inch rectangular
- 10-inch diagonal
- 8.55-inch by 8.55-inch rectangular
- 18-inch by 18-inch rectangular

Most programs requiring only alphanumerics specified display capacity by characters per line and number of lines. A few such respondents specified screen size in addition to alphanumeric capacity; however, after further discussion it was found that the stated screen size was only a reflection of selected display products. It was found that the screen size factor in alphanumeric-only displays was inserted to assure that the displayed information could be readily viewed from a distance of 2 to 3 feet.

Screen size or display area, however, was of principal importance to respondents of those programs requiring graphics. A major concern of graphics users was proper presentation of high-density presentations to prevent a cluttered presentation. Those respondents requiring alphanumerics and graphics stated character and line capacity and were specific on total viewing area by expressing minimum and maximum screen dimensions. Most programs requiring graphics were specified with approximate 12-inch diagonal rectangular screen sizes indicating only nominal graphic densities. Those respondents desiring map overlay graphics placed the effective map area/dimensions as a highest priority. Minimum map overlay screen sizes were specified as 12-inch by 12-inch minimum with 16-inch by 16-inch desirable. One program with the map overlay requirement specified 8.5 by 8.5 inches as an active display area; however, this was again a reflection of displays currently being utilized. The same respondent stated the need for increased media size to a minimum 12-inch by 12-inch screen for additional map area consideration.

A definite correlation exists between certain information display presentations and character capacity or screen size:

Presentation	Capacity/Screen Size
Alphanumeric only	Specified by character and line capacity
Alphanumeric, miltary symbology, graphics	12-inch diagonal screen size
Alphanumeric, graphics, map overlay	12-inch by 12-inch minimum/ 16-inch by 16-inch desired

The preceding display capacity and screen size requirements occur in the program frequency and quantity requirements shown in table 3.

TABLE 3. DISPLAY CAPACITY/SCREEN SIZE

Category	Type	No. of Programs	Program Content (%)	Quantity Of Units	Quantity Content (%)
1	80-characters by 25 lines	8	22	15,730	63
2	12-inch diagnonal	15	40	5,020	20
3	12-inch by 12-inch (min.) 16-inch by 16-inch (desired)	7	19	4,040	15
4	Other mixed sizes	7	19	400	2

The display capacity/screen size requirements over the spectrum of requirements are effectively covered with the first three categories of display capacities. These three sizes of displays account for 81 percent of surveyed programs and 98 percent of total unit quantities. Although users of alphanumeric-only presentations vary somewhat by character capacities, all these requirements could be satisfied with the 80-character by 25-line configuration. Further investigation is suggested for human-factors considerations in determining a suitable alphanumeric character size and density.

4.3 ENVIRONMENTAL AND PACKAGING

Packaging requirements for display hardware occurred in five groupings:

(1) Submersible
(2) Submersible in transit case
(3) Tactical (no fan)
(4) Mobile (with fan)
(5) Commercial (military user)

The preceding packaging requirements occur in the program frequency and quantity requirements shown in table 4.

TABLE 4. PACKAGING REQUIREMENTS

Category	Type	No. of Programs	Program Content (%)	Quantity of Units	Quantity Content (%)
1	Submersible	1	3	754	3
2	Submersible in transit case	6	16	15000	63
3	Tactical (without fan)	16	42	2658	11

Table 4. Packaging Requirements (Continued)

Category	Type	No. of Programs	Program Content (%)	Quantity of Units	Quantity Content (%)
4	Mobile (with fan)	13	34	6708	27
5	Commercial (military user)	2	5	102	1/2

In the packaging category, approximately 76 percent of the programs surveyed fit into the Tactical category with the respective percentage of breakdowns between fan and no fan indicating the severity of the environmental constraints. Categories 1 and 5 could be considered specialty packaging requirements, but there is insufficient program sampling for conclusive data. Category 2, although representing only 16 percent of the programs surveyed, contained 63 percent of the total display quantities. This category contained the units that can be used in many applications with the most rugged environment dictating the packaging philosophy.

The environmental requirements for display hardware were not as easy to categorize as other parameters. The interview, with the collected data in this area, was not as meaningful inasmuch as most of those interviewed possessed backgrounds in program management, project engineering, or system engineering. The reader is not to interpret this statement to mean that those concerned did not think this category was important, but that the individuals interviewed relied on those expert in this particular area for their knowledge.

As indicated in table 5, the environmental categories could be grossly grouped within certain temperature limits. There were four groupings under this subheading of temperature:

TABLE 5. OPERATING ENVIRONMENTAL CONDITIONS

Category	Type	No. of Programs	Program Content (%)	Quantity of Units	Quantity Content (%)
1	-32° - +55° C	15	39	3341	13
2	-28° - +65° C	6	16	15554	62
3	0° - +50° C	7	18	2444	10
4	A variety of Mil Specs	10	26	3811	15

Categories 1 and 2, representing operating environmental (temperature) conditions, show approximately 75 percent of the units with a stringent tactical requirement. There was little correlation between packaging and environmental requirements. The environmental requirements in an airconditioned van or shelter were benign, but the requirements for ruggedization were stringent.

The environmental/packaging categories, when surveyed, could be aided in the future by (1) notifying the interviewee in advance that this area is to be explored, and (2) encouraging those interviewed to request help from other personnel knowledgeable in supporting disciplines (although this suggestion would add to the length of the interview).

4.4 OPERATING POWER REQUIREMENTS

As a result of all programs surveyed, there were three general-type power requirements. The three operating power requirements occurred in these groupings:

(1) 28V, DC
(2) 28V, 115/230V
(3) 115V, 50-60 Hz, to 400 Hz

The three categories occurred in the program frequency and quantity requirements shown in table 6 with only 27 programs reporting.

TABLE 6. POWER REQUIREMENTS

Category	Type	No. of Programs	Program Content (%)	Quantity of Units	Quantity Content (%)
1	28V, DC	7	18	3,024	14
2	28V, 115/230V	5	13	14,800	68
3	115W, 50-60 Hz, 400 Hz	15	40	3,898	18

The additional programs not represented in table 6 contained power requirements not defined at the display level, but considered as a prime contractor responsibility, or alternatively, the GFE supplier responsibility. Category 1, or the 28V, DC requirement, represents the highly tactical programs operating from vehicular batteries or power sources wherein the system must operate in a standalone mode.

Category 2 represents programs that may operate in full tactical or Command Center environments. The utilization of central power generating equipment acts as auxiliary power equipment and allows for recharge and maintenance updates.

Category 3 represents fixed and mobile centers that have access to command center power generators or commercial power, or programs in advanced development that will require 28V in the engineering development or production phase.

New advances in electronic technology make the use of a universal power supply with various input/output parameters feasible and cost effective. The modular approach to power supplies for the military users is being investigated and adapted to subsystem equipments. The modularity of the universal power supply for various display requirements should be flexible and cost competitive.

4.5 MAINTAINABILITY

The maintainability requirements for hardware systems focused on both field- and depot-level maintenance with the emphasis on field maintenance. The mean time to repair (MTTR) measure, the most popular response to this category question, was tied in to the lowest repairable unit (LRU) concept. In the field the LRU was at the board, subsystem, or complete box level. Maintainability requirements for the display hardware (table 7) occurred in three main groupings of MTTR at the field support level:

(1) 30 minutes
(2) 15 minutes
(3) 20 minutes

TABLE 7. MAINTAINABILITY

Category	Type	No. of Programs	Program Content (%)
1	30 minutes	16	42
2	15 minutes	10	26
3	20 minutes	7	18

(Only 33 programs reported here; other programs had no stated maintenance policy.)

In gross MTTR numbers, the time to repair units at the depot rather than in the field was approximately 2 to 3 times as long, and of course reflected the severity of the failure to be corrected. With the advances of new technology, the "throwaway module" concept will improve the MTTR since the module may be a complete board or subsystem, but the attendant support hardware costs may increase.

4.6 RELIABILITY

The reliability requirements for subsystems are dictated by overall system reliability. Most interviewed program managers were generally aware of system reliability goals, but they were not in a position to establish the reliability requirements for the display except when the display was a directed government-furnished item. Thirty-seven percent of the programs surveyed fell into the GFE category and required a display reliability figure of 2,000 hours. The remainder of the programs surveyed, or 63 percent, had reliability requirements so dispersed that no trend was obvious. Twenty-four programs required reliability figures for the displays of from 500 hours to 5,000 hours, with no significant numbers of programs locked into any particular figure. Reliability is an inherent requirement for all military systems, but the concrete identification of a reliability-required number that designates a "good system" or a "good subsystem" is difficult to obtain from most general planners.

4.7 SERVICE LIFE

The operating service life requirements of the displays extended from 7 to 20 years. Combinations of the operating life occurred in three groupings:

(1) 10 years
(2) 15 years
(3) Isolated requirements of 7, 20, and unknown

The preceding operating life groupings occur in the program frequency and quality requirements shown in table 8.

TABLE 8. SERVICE LIFE

Category	Type	No. of Programs	Program Content (%)	Quantity of Units	Quantity Content (%)
1	10 years	26	68	10,317	41
2	15 years	7	18	441	2
3	Others	5	13	14,491	57

Operating life of most military equipments is 10 years in the planning cycle. the statistical breakdown, even in a small sample, supports this philosophy. the large number or large quantity of units in the "Others" category reflects the transition of some very small number of programs into full-scale production with the requirement that these production equipments will extend the operating life of the equipments to 20 years.

4.8 HUMAN FACTORS

Operator considerations were surveyed in two general categories: (1) operator viewing and ambient light conditions, and (2) operator interaction with the display device.

Of the programs surveyed, 32 (84 percent) stated the need for a single, seated operator with four programs specifying the need for multiple personnel viewing a single display. (Only 36 programs reported on this category.) Thirty-eight respondents stated operating ambient light condition requirements as follows:

- Normal office/shelter ambient light - 26 programs
- Full sunlight to total darkness - 12 programs

All of those specifying operation in full-sunlight condition qualified the requirement by stating that display-screen viewing was not required in direct sunlight. Many of those interviewed who specified viewing in total darkness indicated the need for contrast ratios greater than 25 : 1 in 5-footcandle illumination, with the average screen brightness greater than 30 footlamberts.

Operator interaction requirements over all programs displayed considerable dispersion. Such interactive means included:

- ASCII keyboards (64 and 96 keys)
- Numeric pads
- Varying complements of special function keys
- Editing keys
- Mode change key legends
- Touch panels
- Light pens
- Menu interaction
- Trackball censor
- Joystick cursor
- Specially configured keyboards

The survey uncovered practically every means of known interaction capability with the exception of voice recognition and entry. The findings of this study dictate excessive dispersion of interaction requirements or combinations to define effective sets of interactive capabilities. This is not to suggest that this dispersion evidence is conclusive. In fact, further survey and analysis in this area could provide organization over a large number of interactive requirements.

4.9 IMAGE FACTORS

The topic "Image Factors" is defined as the image quality of the display. Further specific definitions of the image quality contain the terms *brightness, contrast,* and *ambient conditions* of the survey displays. The

brightness to the ambient light conditions, one arrives at the *contrast measure*. Brightness is a psychological factor involving human perception of the image. *Luminance* is the measurable item leading to the derivation of contrast.

In the 38 programs surveyed, the ambient conditions for the display operations were divided into two categories:

- (1) Shelter and/or office level environment . . . 25 to 30 foot-candles
- (2) Complete spectrum of sunlight to darkness

These *ambient* requirements occurred in the program and quantity requirements shown in table 9.

TABLE 9. AMBIENT REQUIREMENTS

Category	Type	No. of Programs	Program Content (%)	Quantity of Units	Quantity Content (%)
1	Shelter/office environment	26	68	7,815	31
2	Sunlight to darkness	12	32	17,434	69

From this breakdown, some 26 (or 68 percent) of the programs surveyed actually utilized a controlled *office similar environment*. Thirty-one percent of the units were represented in this category.

Category 2 exemplifies the more tactically oriented displays in which the system may be operating not only in direct sunlight but in any combinations of sunlight to darkness.

These 12 programs represent some 69 percent of the total quantity, and although the programs are small in numbers, these display requirements are difficult to satisfy and represent the large number of tactical equipments.

Contrast is expressed as a ratio of two numbers (e.g., 25:1, 5:1, 4:1, etc.) To be specific and meaningful, the contrast ratio must be tied to the proper ambient condition, as well as a discussion of the optical filtering used (if any).

Of the 38 programs surveyed, 25 did not specify a contrast ratio. The remaining 13 programs requiring the contrast ratio ranged from 4:1 to 25:1 with various subjective conditions. The display must be viewable to the operators. [Author's comment: This requirement tied to the ambient conditions seemed adequate to those surveyed.]

Display brightness was not discussed for any of the 38 programs. This item would be left to the prime or system contractor and was not an item that concerned those interviewed.

4.10 OPERATOR INTERACTION

In the survey of the 38 programs, the operator interaction category had great dispersion. The simplest operator interaction occurred in 21 percent of the programs where the qualifications for the operator would be similar to those of a clerk-typist. The display information consisted of alphanumeric, punctuation, and minor special symbols. The operator transmitted and received simple alphanumeric information that usually could be composed and edited offline.

In 71 percent of the programs surveyed, the operator qualifications ranged from O-3, E-6, to E-2. The specialist ratings range from DF and EW analysts as well as overall system analysts to communication specialists of all disciplines. The display is used as a reporting device, as a control device, and as a pictorial device in different project applications. The operator interaction in these diverse applications is also so diverse that in the

total of the surveyed programs, this category was too dispersive to even roughly correlate, but it did show the breadth of operator interaction. The operator interaction category should be investigated more in detail and should be tied more directly into the various complex system applications for displays.

4.11 ELECTRICAL AND COMMUNICATIONS INTERFACE

Thirty-four programs surveyed, or 89 percent, reported that the main purpose for the display was a computer peripheral. The electrical interface was some type of digital input/output port to the minicomputer. The actual digital interface was described in the various programs as follows:

- Data bus controller
- High-speed parallel transfer
- 8-bit parallel via data bus
- Multiplexer on data bus
- Single-ended parallel data port input/output
- 9-bit parallel interface
- Military-Standard-188-C
- 8-bit differential to minicomputer

The specific requirements or reported interface specifications were so diverse that little correlation was possible. Very little standardization or callouts on the processor or minicomputer were noted. Inasmuch as the survey did include programs from U.S. Army, Navy, USAF, and USMC, the lack of correlation of minicomputer types would perhaps be expected, the lack of correlation within a service would seem to dictate further evaluation. The remaining four programs surveyed, or 11 percent, indicated an interface to analog systems as well as raw video. The surveyed programs in this general category were small in number, and no meaningful data can be excerpted except that there were programs of this category in the overall 38 programs surveyed.

4.12 PHYSICAL AND MOUNTING REQUIREMENTS

The requirements for mounting and the associated physical size were diverse. An attempt was made to organize the general information obtained into groupings. The combinations of the physical and mounting requirements occurred in four groupings.

1. Tabletop, hard mounting, minimum size
2. Rack mount (nominal 19-inch rack mount in contractor equipment)
3. Display integrated into contractor-designed and contractor-furnished consoles
4. Standalone display packages (various sizes)

The preceding physical and mounting requirements combinations occurred in the program frequency and quantity requirements shown in table 10.

TABLE 10. PHYSICAL AND MOUNTING REQUIREMENTS

Category	Type	No. of Programs	Program Content (%)	Quantity of Units	Quantity Content (%)
1	Tabletop	11	30	17,856	71
2	Rack mount	11	30	1,371	5
3	Integrated console	9	24	2,733	11
4	Standalone	7	16	3,289	13

The tabletop mounting requirement occurred in only 30 percent of the programs, but 71 percent of the units surveyed were in this category. Within the constraints of the mounting requirement, the actual equipment size varied and reflected individual contractor design efforts, as well as an overall specification requirement for minimum size and weight.

4.13 DISPLAY DATA MANIPULATION FEATURES

Display data manipulation features included scrolling, editing, data differentiation, writing speeds, and so on. Under the category *Display Information*, the types of information displayed, such as alphanumerics, graphics, and symbology, can be correlated directly with the display data manipulations features. Scrolling, editing, and others not included here are correlated with alphanumeric systems. Areas such as data differentiation and writing speeds are usually associated with graphics systems.

These topics, scrolling and editing, elicited some response from those in alphanumeric systems or displays but none in the graphic community. Under the general heading of graphic systems, writing or directly related update speeds were meaningful as well as the practicality of data differentiation where the possibility for color displays could be important.

In a survey of more programs that could be dramatically divided to include a gross separation between alphanumeric and graphics, these questions could be pinpointed toward a response that could be important for the technical display designers. The data received in this particular survey topic was insufficient to determine any evidence of commonality or dispersion.

4.14 COST OBJECTIVES

Of the 38 programs surveyed, 14 reported that the display costs were so interrelated with the terminal costs that no specific number could be associated with the display. As a subsystem, the display package is dictated and described by the contractor. The specific role that the display will play in that contractor's program will result in not only size, weight, and technical constraints but also costs.

Of the 38 programs, 8 or 21 percent, contained displays that were either GFE or GSA callouts. Since these displays are nomenclatured and cataloged, the particular costs were identified by those surveyed.

The remaining 16 programs reported cost data on displays ranging from $3,000 to $250,000. These figures are subjective and of little value without information on the display content. Further investigation and evaluation of cost objectives and cost history would be invaluable for budget planners.

4.15 PRIORITIES OF IMPROVEMENT

The question on priorities of improvement in the survey sheet was the most difficult to answer. The interviewees were reluctant to admit to potential shortcomings in the display area. Another factor was related to the phase of the surveyed program (planning, advanced development, engineering development, etc.).

The surveyed program answers did fall into the following categories:

1. Lower cost
2. Improved reliability
3. No improvements
4. Increased physical size of the display

The program groupings and statistics are listed in table 11.

TABLE 11. PRIORITIES OF IMPROVEMENT

Category	Type	No. of Programs	Program Content (%)
1	Lower cost	10	26
2	Improved reliability	11	30
3	No improvements	15	39
4	Increased display size	4	11

The 26 percent of the programs that are reported to seek lower display costs are those programs that, in effect, reported that the displays were too costly. Actually, nearly all the interviewees wanted more display per dollar, or specifically if color would help in data highlighting, that was desired at no extra cost. If the graphic mode could be included at no additional cost, that would be a plus even though the requirement might not exist at this time for that mode.

Eleven programs (30 percent) requested a display with improved reliability within the present cost constraints. The contractual reliability figures were not being met for military-type equipments, and for some of the programs to move on to subsequent phases, the display and system reliability goals had to improve.

Category 3 (no improvements) was the largest of the program content, 39 percent. This number, in part, was due to the particular program sample in which some of the programs were in a preproposal period, had just been awarded a contract, or were in the early phase of development. Obviously, any sample would contain several in this category that would vary.

Four programs (11 percent) requested the larger display size. All these programs fit into the type of program that required map overlay or map background. Map scales, map sizes, map availability, and required coordinate resolution are all interrelated to this need and will dictate future display requirements for those specific users.

There are more than 38 responses in this category since some programs surveyed had more than one priority of improvements.

Section 5
MILITARY PROGRAM CONTENT

Of the 38 military programs surveyed, 28 (74 percent) were administered by the U.S. Army. The high U.S. Army content is primarily because of U.S. Army CENTACS/CORADCOM sponsorship of the study. Although few U.S. Marine Corps programs were surveyed, those that were are representative and significant in future military display needs. Although several of the programs surveyed are multiservice in application, the following list of programs is organized on a principal service application or administering service basis:

U.S. Army

TOS
AN/TYC-39
TACFIRE
SST
MRTT
AN/MSC-64
BCS
AN/GSC-( )
Firefinder
AN/USC-28
Trailblazer
Quick-Look II
Guardrail V
Quick Fix
RPV/GCS
SOTAS
TACJAM
SSL
TACELIS
Beta 1 and 2
BSTAR
DIVAD
CAC
ASAS
AGTELIS
AN/MSQ-103
MULTEWS

U.S. Army Programs = 28

U.S. Navy	U.S. Air Force	U.S.M.C.
NTDS	JTIDS	MACS-85 (TAOC-85)
FCC	TCCF	MIFASS
Seawatch	EC-135	TCO
AN/WLR-14		
U.S. Navy Programs = 4	U.S. Air Force Programs = 3	U.S.M.C. Programs = 3

TOTAL = 38

The total quantity of militarized display units identified over the life of the programs surveyed is 25,249. Military service allocation of those surveyed is as follows:

U.S. Army (28)	- 19,000 units
U.S. Navy (4)	- 2,154 units
U.S. Air Force (3)	- 3,295 units
U.S.M.C. (3)	- 800 units
	25,249 total units

Of the 19,000 units identified for U.S. Army application, 14,000 are attributable to two tactical field communications programs, Modular Record Traffic Terminal (MRTT) and Single Subscriber Terminal (SST). These programs dominate the quantity usage of subsequent military display needs. Therefore, the study findings represented by quantity designations of prospective units requiring certain features are in part presented both with and without the quantity of 14,000 units.

Although the scope of the study was not intended to survey the complete military display market, an objective was to arrive at a representative sampling of militarized display requirements and estimate the overall military display market size.

Candidate Army programs were initially selected from a comprehensive list of 173 U.S. Army programs entitled "Battlefield Automation for Defense Systems." Programs were further categorized under the following applications:

Application	Number of Programs
Command and Control	9
Communications	35
Airborne Avionics	4
Weapon Systems	20
Combat Support	56
	173

Of the candidate 173 U.S. Army programs identified, approximately 50 percent were probably not valid for this study for one or more of the following reasons:

- Program included no display content
- Display requirements were outside the scope of the study
- Program was not funded or was not likely to mature

A reasonable estimate is that the 28 U.S. Army programs surveyed represent approximately one-third of the programs that could have potentially been surveyed with applicable militarized display content. Of the 28 U.S. Army programs surveyed, two exceptionally large-quantity programs (MRTT and SST) accounted for 14,000 display units with a balance of 5,000 units spread across the remaining 26 programs. If the display unit density would be the same over the 56 unsurveyed Army programs, an estimate of Army display unit requirements is as follows.

MRTT and SST programs	14,000 units
Other twenty-six programs surveyed	5,000 units
Unsurveyed programs	10,000 units
Total U.S. Army display requirements	29,000 units

As shown in table 12, the surveyed quantity of 19,000 militarized display units for Army applications, therefore, represents a 65 percent sampling of estimated U.S. Army display needs over an availability period through 1988. As shown in table 12, fewer programs were surveyed for the other military services; however, an estimate of all service requirements over the same 8-year period is suggested.

TABLE 12. PROGRAMS SURVEYED BY SERVICE

Service	Programs Surveyed	Quantity Surveyed	Estimated Survey Sampling (%)	Total Estimated Quantities
Army	28	19,000	65	29,000
Navy	4	2,154	10	21,540
Air Force	3	3,295	20	16,475
Marine Corps	3	800	50	1,600
Total	38	25,249		68,615

To arrive at an estimate of costs to the government of military display devices over the next 8 years from the preceding quantity estimates, several cost factors should be considered.

- Present costs of militarized displays/terminals
- Applications of cost-effective display technologies

- Potential large-volume military display contracts resulting in volume economics

- Cost-effective display technologies in the commercial sector

Considering the preceding factors, a projected minimum average cost to the government of $15,000 per unit over the next 8 years is conservative. Accordingly, the total cost to the government of military display devices over the 8-year period is $1.03 billion, or an average cost per year of $128 million.

Section 6
CONCLUSIONS AND RECOMMENDATIONS

The study survey phase resulted in the survey of 38 programs, each with militarized display content consistent with the scope of the study. the survey data sheets for all surveyed programs have been documented and submitted. Areas of substantial commonality or dispersion were identified and have been discussed in section 3, "Survey Findings."

The requirements have also been classified and segmented in section 3. A profile of program priorities has been established as it would apply to the display subsystem. The survey covered programs in various stages of maturity, ranging from conceptual phase through full-scale production.

An estimate of costs to the government of military display devices over the next 8 years based on the quantity estimates generated in section 5, "Military Program Content," has been completed.

A projected minimum average cost to the government of $15,000 per unit over the next 8 years is conservative. Based on an estimated total display quantity requirement of 68,615, the total cost to the government of military display devices over the 8-year period is $1.03 billion or an average yearly cost of some $128 million.

While certain requirement areas over the spectrum of programs demonstrated commonality merits, there were *no* areas that possessed any single common requirement in every display. Some areas, however, did demonstrate discrete groupings of requirements that suggest multiple display configurations could effectively cover the application spectrum.

The survey results pinpoint existing and escalating costs as the factor pertinent to the majority of program managers. Improved display technology, if it results in lower costs, is desired. Improved technology reflected in improved life-cycle costs of the complete system would be considered by both government and contract program managers, but this item will have to be proposed and considered objectively.

CRT and flat panel technologies were included in the survey findings of display devices. No particular technology was suggested or recommended as a problem or program solution.

If the two large-quantity unit programs are deleted, then 30 percent of the total displays required map overlay, and an additional 20 to 30 percent of the programs would use the map overlay capability if it were available.

A prime objective after the completion of the requirements study should be a definition of the methodology involved in the productization of the end items or peripherals of a military computer family. Consider the MCF display subsystem as a small system. From the results of this survey sample, the display subsystem can be partitioned into a discrete number of modules, not necessarily hardware, some of which can already be defined specifically enough to generate clear and rigid specifications. One partitioning method could consider modules of the following type:

- Display head
- Power supply
- Packaging (environment, size, weight, power input, etc.)
- Interaction
- Processor (input/output, firmware, microprocessor)
- Software

concepts family that could satisfy nearly all the specific military requirements for the next 8-year timeframe.

A more detailed study of areas demonstrating significant dispersion and those with insufficient data would entail further contacts, investigations, and analysis, a direct follow-on to the Military/Government Display Requirements.

The physical and mounting requirements, as well as packaging philosophy and constraints, are excellent examples of areas that should be further analyzed and studied on a larger program base. A sample of 38 programs of a potential of 200 to 300 programs is an excellent beginning, but to further validate the results, more systems should be surveyed, analyzed, and correlated.

All aspects of display terminal costs would be investigated. Some reasons for excessive costs are the following:

- Incorrect application of cost-effective display technology
- Small quantity, rather than large quantity, equipment purchases
- Requirements for stringent military specifications where the environment is benign
- Nonutilization of commercial-type display hardware where the requirement has been relaxed

Since costs were so important in most of the programs surveyed, this investigation or study must be detailed and requirement oriented.